Stichting Wageningen Research
Centre for Fisheries Research (CVO)

Gear trials for a new gear for the IBTS

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CVO report: 20.026

Commissioned by:
Ministerie van LNV
Directie SKI
Postbus 20401
2500 EK DEN HAAG

Project number: 4311300078
BAS code: KB-36-002-016

Publication date: 18 november 2020

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This research is conducted as part of the statutory task programme "fisheries research" and subsidised by the Dutch Ministry of Agriculture, Nature and Food Quality.

DOI: https://doi.org/10.18174/535212

CVO rapport ENG V09

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Summary

The North Sea International Bottom Trawl Survey (NS-IBTS) is an internationally coordinated survey. The fisheries-independent indices for young herring, sprat, whiting, cod, haddock, Norway pout and other commercial fish species from the survey are used in fisheries management. As the complete catch is processed, the survey also provides marine ecosystem information. The survey is coordinated by the IBTS Working Group (IBTSWG) of the International Council for Exploration of the Seas (ICES).

The survey setup, including the gear -Grande Ouverture Verticale (GOV)-, is standardised and written down in a manual. The results of an intensive evaluation of the GOV-gear used in the NS-IBTS by different institutes, indicated that all gears differed, and none of them matched the manual exactly. This, together with a wish for a new gear that would be using modern materials, would be cheaper, and able to fish in rougher areas, formed the start of the development of a new gear for the IBTS.
Two new gears have been developed, one by the Marine Institute, Ireland (MI) and one by Marine Scotland Science (MS Science). Both gears have a very similar design, their main difference is the ratio in which the mesh sizes are attached to each other. The main differences with the current GOV are the netting materials used, and the removal of the lower wings.

To test the two gears, MS Science organized a gear trial experiment, for two weeks in November 2019 on board of the Scottish research vessel Scotia. Other members of the IBTSWG were invited to participate, and the Netherlands accepted this, so the WMR gear technician and the RWS boatswain joined the field trial.

This report provides the preliminary results of the trials, along with the observations of the Dutch participants. The preliminary results indicate that both new gears are fishing properly, and both target at least the same fish community as the GOV. There are differences observed in spreading and height of the net, that directly translate into differences in catch composition. The overall conclusion after the trials still is that both new gears would be suitable to replace the GOV.

Having seen both gears operational, it is clear that both nets could be handled on board of the Dutch research vessel Tridens without real adjustments. The Dutch participants had a slight preference for the Irish net, because it is simpler to handle. However, in their opinion the Irish gear should be made of stronger materials to make it more durable and the smallest mesh-size (80 mm) should be made smaller (50 mm). The Scottish gear is currently too heavy for the sandy areas in the southern North Sea if the rigging used during the trials is being used, and should be made lighter. Both gear developers indicated that such adjustments are still possible.

In the IBTSWG in April 2020, the preliminary results of the trials were discussed and it was concluded to continue the current road with the two new gears. Terms of reference were developed for a workshop with gear technicians end of 2020, early 2021 to discuss the materials, the rigging and further development of the gears into a single new gear for the North Sea IBTS. After this workshop a final net should be made, which can then be used on trial fisheries by each institute involved in the IBTS. The further roadmap for implementing the new gear in the near future, was drafted by the ICES Workshop on impacts of planned changes in the North Sea IBTS (WKNSIMP) in 2019, and includes a transition period in which both gears, the current GOV and the new gear, will be used in the NS-IBTS.

1 Introduction

1.1 Development of the International Bottom Trawl Survey and its gear.

As early as 1960, four large international surveys under the auspices of ICES mapped the distribution of juvenile herring (*Clupea harengus*) in the North Sea and investigated the links between herring nursery grounds and the adult populations (ICES 1963, 2010a).This exercise developed into the International Young Fish Survey (IYFS) and in 1990 into the International Bottom Trawl Survey (IBTS) (Heessen et al. 1997). By that time eight countries participated and the survey covered the North Sea and Skagerrak/Kattegat. Since 2006, the IBTSS has been expanded into the Channel and from 2016 onward the survey expanded slightly further north. The survey currently provides the fisheries-independent indices for young herring, sprat, whiting, cod, haddock, Norway pout and other commercial fish, which are used in fisheries management. As the complete catch is processed, the survey also provides marine ecosystem information.

Before the North Sea IBTS became a fully coordinated international survey, many survey gears were used (ICES 2010a). It started with Herring trawls, and when the focusses shifted towards more species also the gears changed to multipurpose gears. In 1976, six different survey gears were being used by eight different nations. By 1983, all nations participating in Q1 were using the GOV 36/47 (Figure 1-1,Figure 1-2), albeit with slightly different rigging configurations of the sweep lengths (depending on depth). Since then, the GOV has been the recommended standard gear of the IBTS and by 1992, the GOV was used in all quarters of the IBTS.

A single standard gear was prompted by work conducted on the impact of differences in the netting material, the rigging and handling of the gear (warp length, fishing speed) (ICES 1992). It was advised to standardize the methods between the countries as much as possible and to document the detailed aspects of the gear and fishing method. Despite that some persistent differences between countries remained, for example the Scottish IBTS required a more robust hard ground gear (type 'B', introduced in the manual of 2010 (ICES 2010a)). Also the impact of handling was already acknowledged (ICES 1992) and while some advice for standardization to limit variation was given this was not adopted, e.g. constraining lines between the doors (ICES 1994).

The GOV is also used in a number of North eastern Atlantic IBTS surveys (ICES 2017). On the Scottish SW IBTS surveys a hybrid design of the GOV trawl is used, with the front end constructed from polyethylene (PE) netting and the rear part (end taper, straight section and blinder) constructed from nylon (PA) netting. No discernible differences in gear geometry compared to the full nylon trawl were shown. In 2006, England wanted to move from the standard nylon (PA) GOV to a full Polyethylene (PE) net (Harley and Ellis 2007). The reason to change their net in the SWIBTS was because the Polyethylene netting is more durable and can be used to fish in rockier grounds. The reason for the NS-IBTS was that they were no longer able to source the nylon GOV so in the future it will be necessary to change over to the PE (ICES 2010b). Results of English experiment showed clear differences in gear geometry and length of the fish in the catch between the full nylon and the full Poly trawl. As a result, a change to a full polyethylene net was not accepted by the IBTSWG. Instead England started to use the hybrid GOV.

The IBTSWG-discussions about England changing the net made clear that more changes had occurred over time in most countries. This is not a big surprise as a survey trawl is a complex system which is constructed from a wide variety of components. The standard net and associated fishing components are ordered from a netmaker or made in-house. A standard survey trawl can be in service for a considerable period and therefore this can often lead to "modifications" creeping in that may alter the performance of the gear. Furthermore, over time alterations can be made to how a survey trawl is deployed such as warp to depth ratios, the use of long/short sweeps or introduction of a new survey vessel. Also problematic are changes in materials used in a survey trawl construction due to components becoming

unavailable because they are no longer manufactured and the effect this might have on the catchability of the gear.

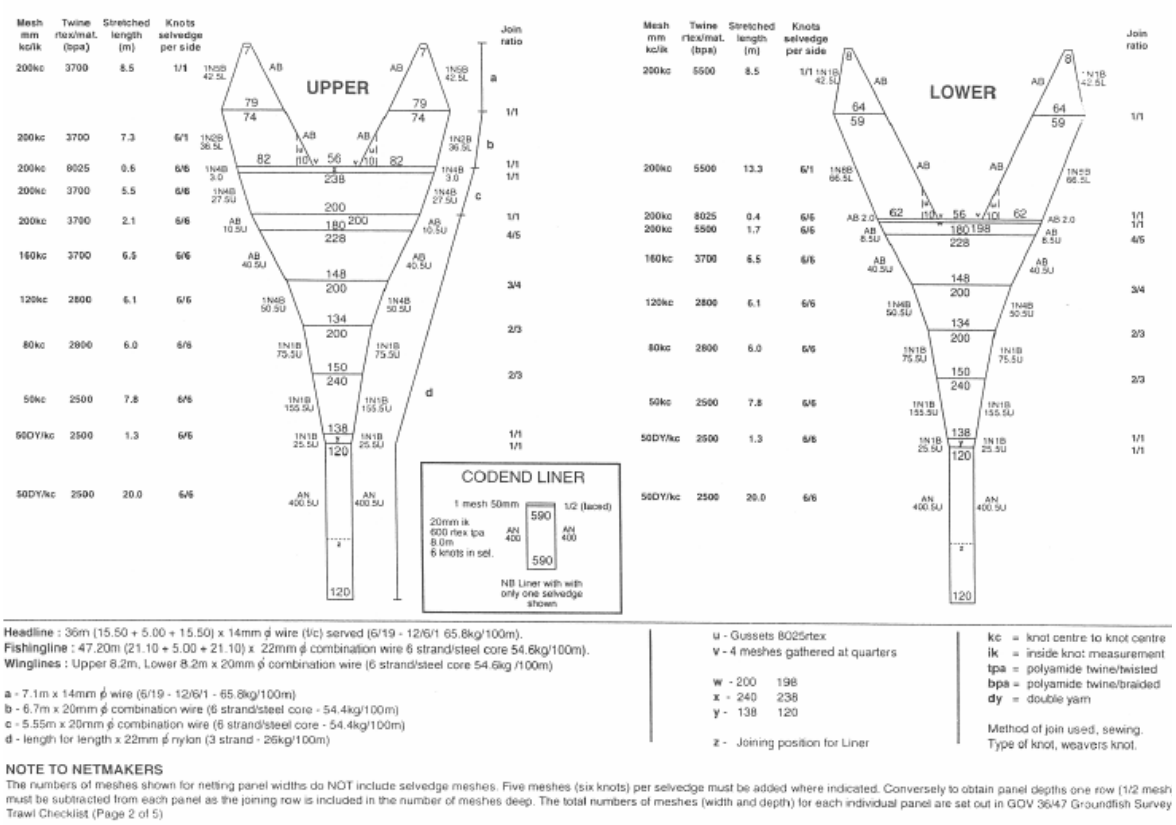


Figure 1-1 The construction of the GOV 36/47 trawl (ICES 2010a).

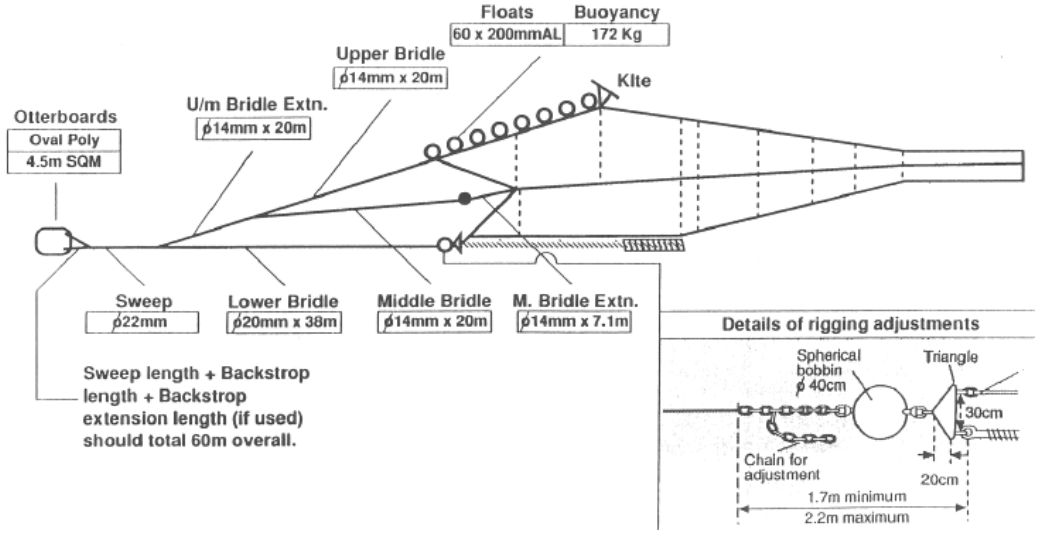


Figure 1-2 The rigging of the GOV 36/47 trawl (ICES 2010a).

To make these creeping "gear modifications" clearer, the IBTSWG 2013 evaluated the differences in survey gears currently being used in the IBTS (ICES 2013). This evaluation showed that differences occur between institutes and deviations of the manual occur for all countries (ICES 2015). These occur in the trawl sections, trawl roping and framelines, the ground gear construction, flotation and kite, wire rig and otterboards. The conclusion was that none of the GOV constructions in use matched the description in the manual exactly, and the gears are not comparable. In most cases this drift is undocumented. Anecdotal information suggests this has continued significantly since the review in 1992 (ICES 1992).

1.2 Multiple reasons for a change

1.2.1 North Sea IBTS

The observation by the IBTSWG on creeping modifications of the gear, questions the consistency of the NS-IBTS time series and called for some action. Partially, correction for the modifications is possible by including vessel effects in the analyses, as there is deliberate spatial overlap between countries in the current survey design. That however will not easily consider drift within a single institute and becomes complex when new vessels are introduced or countries rent each other's vessels. Returning to the manual and remaking all the national gears would cause a "big" break in the time series, let alone that many parts of the gear are no longer available. Furthermore, a Scottish gear technologist within the IBTS group tried to make the GOV from scratch based upon the current manual. This showed that the description is incomplete, so arbitrary choices had to be made, and will need to be made by each manufacturer making the net.

Next to that, many people find that there is a flaw in the design of the GOV, and that it is a complicated gear to handle and maintain. There is a wish for a simpler gear than the current GOV. In many countries GOV-type of gears are no longer in use in the commercial fishing, and as a result the experience of fishing crew with this type of net and netting material is decreasing. Because of this handling and repairing the net becomes more and more difficult on board.

Also, ecological aspects play a role. Species have shifted their distribution further north into deeper and rockier areas and there is increasing demand for wider ecosystem information. This means that there is a wish to cover areas that can't currently be fished with the GOV.

The combination of above arguments led to the plan to develop a new survey gear for the North Sea IBTS.

1.2.2 North-east Atlantic

The arguments for a new gear in the north east Atlantic surveys come from a slightly different viewpoint. As for this area, there is only a handful of combined indices, a new vessel often is seen as an opportunity to make some changes for that individual survey, assuming that the combined time series will not be broken by a change of vessel. Likewise, a lot of indices are assumed independent, so neighbouring indices can support intervening years in the same way as when a vessel breakdown requires surrounding data to be compiled to compensate for a missing survey.

1.3 Gear development process

For the development of a new gear two routes were taken. The gear technologists of Marine Institute, Ireland (MI) and the Marine Scotland Science (MS Science) both developed a gear that according to them would meet the current requirements. While developing these gears both institutes used the guidelines of the SGSTS (ICES 2009). It resulted in according to themselves two relatively similar nets. These were separately tested in 2018 and for 2019 in a combined gear trial experiment on board of the Scottish vessel Scotia. All the IBTS countries were invited to participate in this experiment.

Next to the gear trials experiment, the IBTSWG proposed a workshop to assess the Impacts of planned changes in the North Sea IBTS (WKNSIMP). This workshop looked at the introduction of the new gear and proposed a roadmap for that. It also considered other changes like the redistribution of areas between countries, the effort required and potential changes in stratification. Here, only the issues relevant for the developments of the gear will be further discussed.
The Netherlands participated in the trial in November 2019, and this report describes the observations of the Dutch representatives (WMR gear technician and Rijksrederij boatswain) along with a part of the data analyses done by the Irish and Scottish colleagues.

2 Assignment

The Dutch GOV gear technician took part in the gear trials on board of the Scottish research vessel

Scotia at the end of 2019. The goal of the participation was:

- Get a real-life impression of the new gears
- Discuss the gears and the experiments done with the foreign gear technologists
- Relate the new gears to the Dutch situation:
    - Is it possible to handle the gears on board of RV Tridens?
    - Are there any rigging specifics to get the gear in a proper state on board of RV Tridens?
    - Will the gear be suitable for the shallow, sandy Dutch area?

The experiences contribute to the advice on how to proceed in relation to the development of the new gears, specifically for the Dutch situation.

Next to this, it was an opportunity for the Dutch staff to get involved in the development of the new gears, which was up to then an Irish and Scottish activity. Furthermore, it was an opportunity for the Dutch staff to see the Scottish methods for fishing, sorting the catch, and data gathering. As always advised by the IBTSWG, an staff exchange is a good way to improve the standardization between countries.

3 The new Gears

3.1 Scottish (BT237)

The proposed survey trawl design (BT237) has cutaway lower wings, and along with that also the middle bridle is left out (

Figure 3-1, Figure 3-2). Furthermore, it has guard meshes and tearing strips. This is a typical setup for all nets supplied to the Scottish commercial fishing fleets targeting whitefish species. The only modifications to the commercial trawl specification is the use of smaller mesh sizes in the rear portion of the trawl taper and straight sections. Polyethylene PE twine was used throughout its construction, except for the 20 mm nylon blinder installed into the 50 mm codend cover. The smallest mesh size is thus 50 mm. The gear was fished with 47 m single sweeps and twin 40 m wire bridles, 16 mm diameter upper and 20 mm lower.

The rockhopper ground gear (Plate II) was constructed from four rockhopper sections incorporating 300 mm discs in the centre and 250 mm discs along the wings with an overall length of 24.4 m. The ground gear is attached to the lower bridles via 350 mm bunt sections plus 8.84 m extension chains. The spacing of the rockhopper discs in the centre, quarter and wing sections were 100 mm, 170 mm-250 mm and 340 mm respectively.

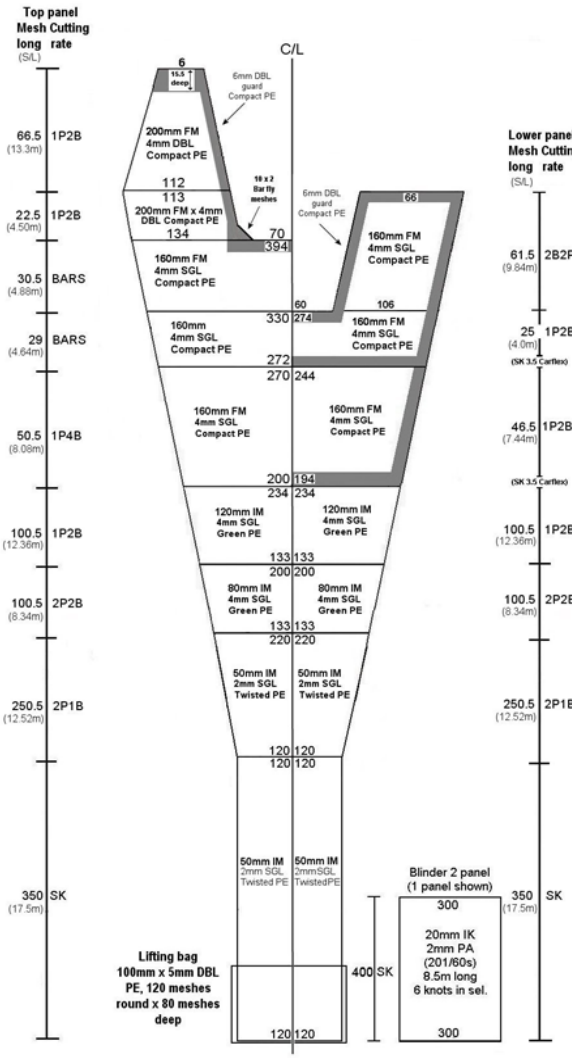


Figure 3-1 The construction of the Scottish BT237 gear.

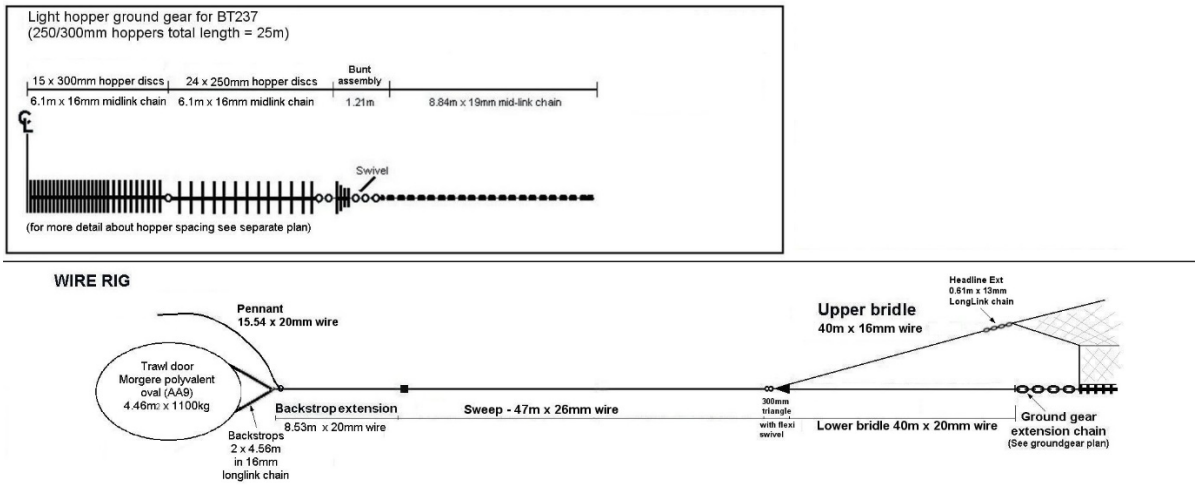


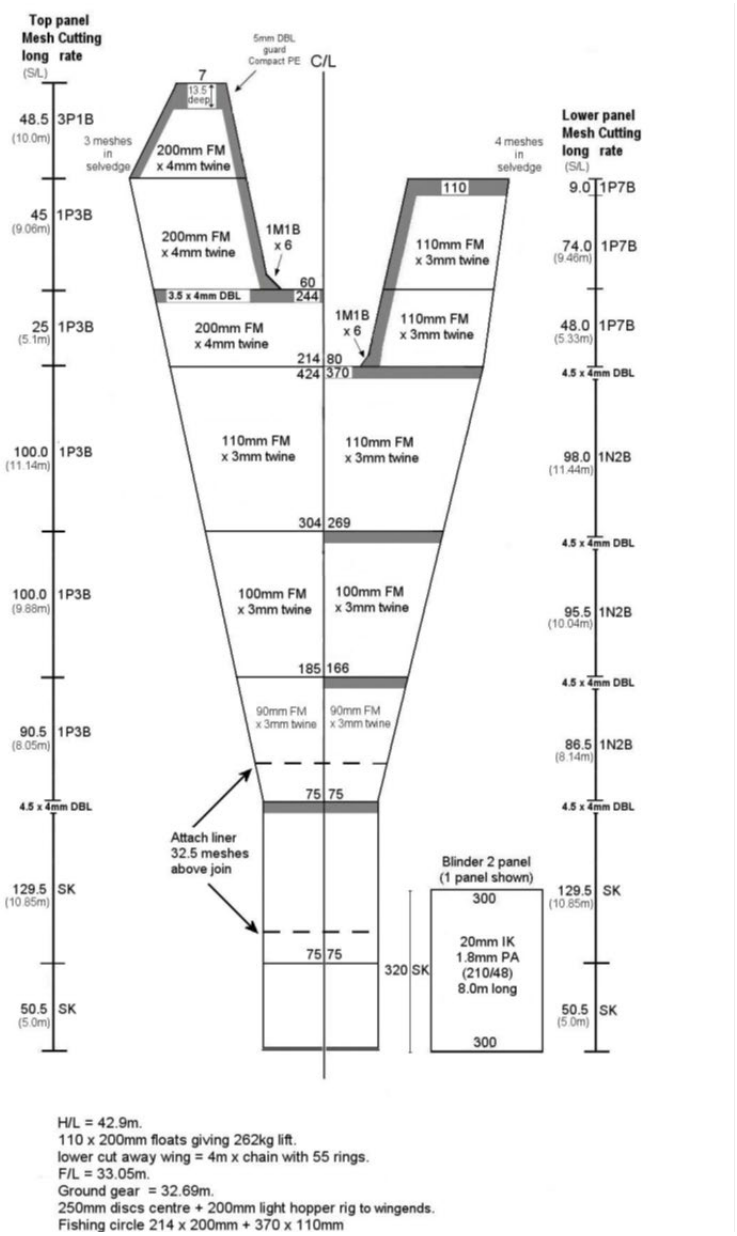
Figure 3-2 The wire rig used for the Scottish BT237 gear.

3.2 Irish gear (MI trawl)

Like the Scottish trawl, the proposed Irish survey trawl also has cutaway lower wings (Figure 3-3, Figure 3-4). The design focussed on simplification of the net, resulting in a simple net construction centred on the mesh sizes for the various panels. The standard GOV has five different joining ratios between panels as well as multiple cutting ratios to taper the net along its length. To simplify this, the proposed design solution from the Marine Institute has a simple 1/1 joining ratio between panels throughout the trawl and a constant cutting ratio for the taper as well. Joining panels of one mesh size to a smaller mesh panel on a 1/1 ratio is a very simple join compared to more complicated ratios with the required strollers (Figure 3-5). This makes repairs at sea as simple as technically possible regardless of deck space or experience of the crew.

This simpler approach is only possible with small reductions (probably <12mm) in mesh size between adjoining panels. This means a larger number of panels (steps) is required between the same maximum and minimum mesh sizes for a given trawl. Selecting the mesh size for the various panels is a trade-off between selectivity and time to repair. Most trawl damage happens at the front of the trawl so, as with any net, the further forward you come with smaller meshes the multiples of hours you have to spend repair a trawl after any significant damage. Conversely, the further back you go with larger meshes the more small fish you are likely to be losing through the meshes. Water flow through the trawl is also a mesh size consideration, but less significant than selection/repair. The alternative is to have several panels, very close in size, so they can be joined by a simple 1/1 join across the panel. This offers maximum flexibility in mesh size selectivity and any additional work in construction is done on land before the survey, and so, it is the quickest and simplest design to repair at sea. The straight joining then facilitates the introduction of a few simple tapers and in this trawl. There are just three tapers in the main body of the trawl (Figure 3-3), compared to five in the standard GOV and in the new BT237.

Another difference between the MI and BT237 is the mesh sizes in the rear portion of both trawls. The MI-trawl reduced to 78 mm compared to 50 mm in the BT237.



H/L = 42.9m.
110 x 200mm floats giving 262kg lift.
lower cut away wing = 4m x chain with 55 rings.
F/L = 33.05m.
Ground gear = 32.69m.
250mm discs centre + 200mm light hopper rig to wingends.
Fishing circle 214 x 200mm + 370 x 110mm

Figure 3-3 The construction of the Irish gear.

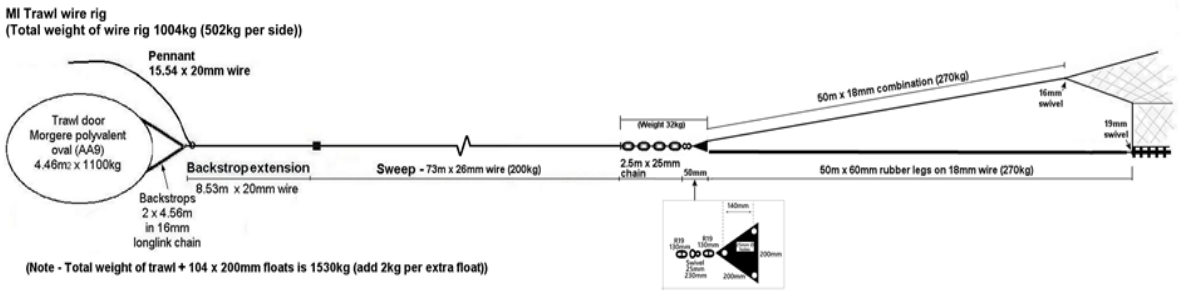


Figure 3-4– Wire rig used for MI Trawl.

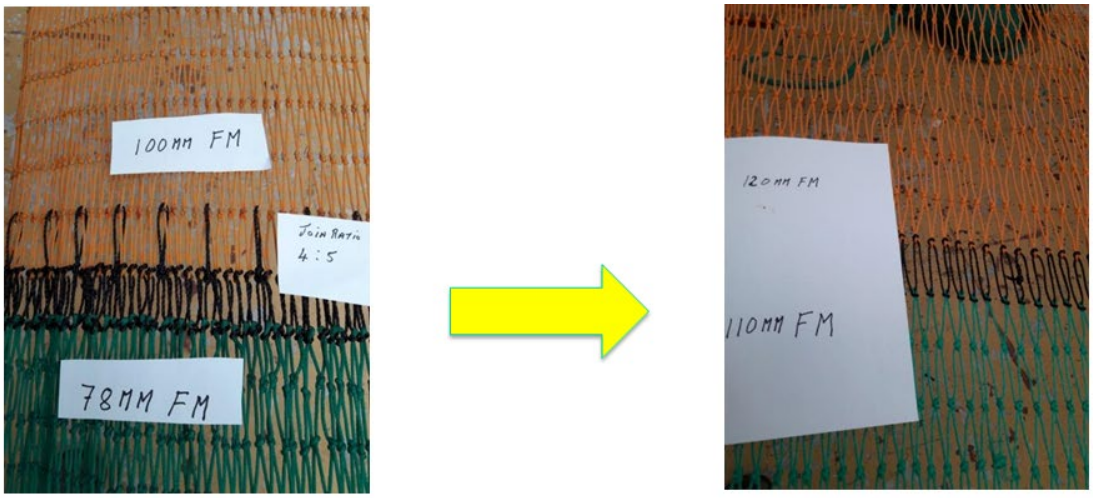


Figure 3-5 The joining ratio of the Irish gear compared to a more complicated joining ration.

4 Scottish gear trials

The gear trials took place on board of the Scottish fisheries research vessel MRV Scotia in weeks 48-49 2019.

The objective of the Scottish gear trials was:

1. To carry out catch comparison trials to compare the fishing performances of the two new survey trawl designs (BT237 and MI trawl) and the standard survey trawl the GOV rigged with gear type A.
2. To assess the fishing performance, in terms of gear geometry, of the BT237 and MI trawls in water depths ranging from 20 m to 100 m.

4.1 Dutch Participation

From WMR, Thomas Pasterkamp participated in the gear trials. Thomas is responsible for the fishing gears of the WOT surveys at WMR. He gained his knowledge on fishing gears, being a former commercial fisherman. He has helped with and been responsible for the gear checks of the GOV for at least 10 years now.

RWS-Rijksrederij also sent one of their staff to participate in the gear trails. As RWS is the owner of the GOV gears, responsible for the maintenance and responsible for the handling on board, this is very important. RWS-Rijksrederij will also need to buy, maintain and handle the new gear. From RWS, Rob van Leeuwen participated in the gear trails. Rob is the most experienced of the two boatswains on board RV Tridens. He has carried out the GOV gear checks prior to the survey for many years and on board he is responsible for the rigging and mending of the net.

Getting approval to participate on board of the Scotia, being a Scottish governmental "building" demanded more than anticipated. Both participants required, next to the standard medical and safety documents, several other documents (disclosure certificate, an original birth certificate, bank statement). Next to that, they also needed to validate the passports prior to boarding, which only could be done in Edinburgh as they were considered foreign staff. As we were not willing to send the passports by mail (as proposed), both had to fly to Edinburgh prior to travelling to Aberdeen to embark.

4.2 Rigging of the gears

For the comparison the Scottish GOV was used, with groundgear type A. This is the same as the ground gear used in the Dutch IBTS. There are some differences between the Dutch GOV and Scottish gear:

- The Scottish kite is the so-called Exocet kite from the IBTS manual while the Dutch kits is a wooden board with fixed dimensions;
- The Scottish net is partially of polyethylene, which is lighter and "floats" compared to the nylon used in the Dutch net;
- The groundgear A is attached differently with more space between the groundrope and the net in the Scottish situation.

The BT237 was rigged with a light rockhopper ground gear.
The MI trawl was rigged with a rubber disc ground gear (Figure 4-1). The 'clean' groundgear employed with the MI Trawl could be considered a modern interpretation of the groundgear type A of the GOV, whereas the light hopper rig used with the BT237 being a groundgear type B replacement.

Figure 4-1 MI Trawl on top drum BT237 on lower drum

The three gears were fished with the same set of Morgere Polyvalent trawl doors, which are the standard trawl doors for all Scottish IBTS surveys. These are also used on board RV Tridens. It is an old design otter board no longer manufactured by Morgere and mostly replaced by an Ovalfoil board, which is easier to use, has a lower fuel consumption and reduced wear. It is likely that with a new gear also a new type of board will be advised.

The MI Trawl required limited fine-tuning to confirm the gear was operating as intended at the IBTS recommended speed of 4 knots (3.5-4.5 knots. However, it was suggested by the trawl designer that the MI gear (weight, buoyancy etc.) was setup to tow at a lower speed of ~3.2 knots. MI considers the slower speed optimal for the primary target species on their IBTS survey. Maximising catchability within a sustained or smaller seabed footprint is a key consideration for MI to update the survey-sampling trawl.

4.3 Fieldwork

The experimental trials were conducted on the MS Science survey vessel FRV Scotia (LOA 68.6m). The cruise ran from 28 November to 9 December 2019. All hauls were carried out in ICES Area IVa within the Moray Firth area off NE Scotland (Figure 4-2). Water depths encountered during the trials ranged from approximately 30 m to 125 m in soft (mud) to firm (sand) seabed substrates. Scanmar acoustic instrumentation was used during every haul to check gear geometry and a self-recording tilt meter (Somerton and Weinberg 2001) attached to the centre of the ground rope monitored seabed contact. Values of speed over the ground and vessel position were output via the Scanmar (Scanbas) control unit to a computer every 20 seconds. Vessel towing speed (3.6 knots -3.8 knots) and warp ratios (3:1) were kept constant for all three gears during comparative hauls to minimise between haul variability. Weather conditions were fine with sea swell height <1m being observed throughout the cruise.

4.3.1 *Experimental design & catch handling*

The procedure for all catch comparative hauls was the same throughout the trials and consisted of paired hauls of between 15 and 20 minutes duration. After completion of the first paired haul, the vessel steamed back to the start position (approximately 60-80 minutes from knockout to block-up) and made the second haul in the same direction but ~100 m parallel to the first haul. At the start of each day, and to minimise bias, the order of deployment was switched so both test (BT237) and control gears (GOV/MI Trawl) were fished either first or second. Furthermore, to ensure the catches of either haul within a paired set were not influenced by towing over dawn or dusk, all hauls were made in daylight.

The catches for all trawls were handled the same way and after each haul, the total catch was sorted into individual species and then weighed by species. All species were measured to the 1.0 cm below (0.5 cm for sprat). When larger catches of a single species were caught, a sub-sample was then measured and raised to the total number caught by the weight ratio of the total weight per species and the weight of the measured fraction.

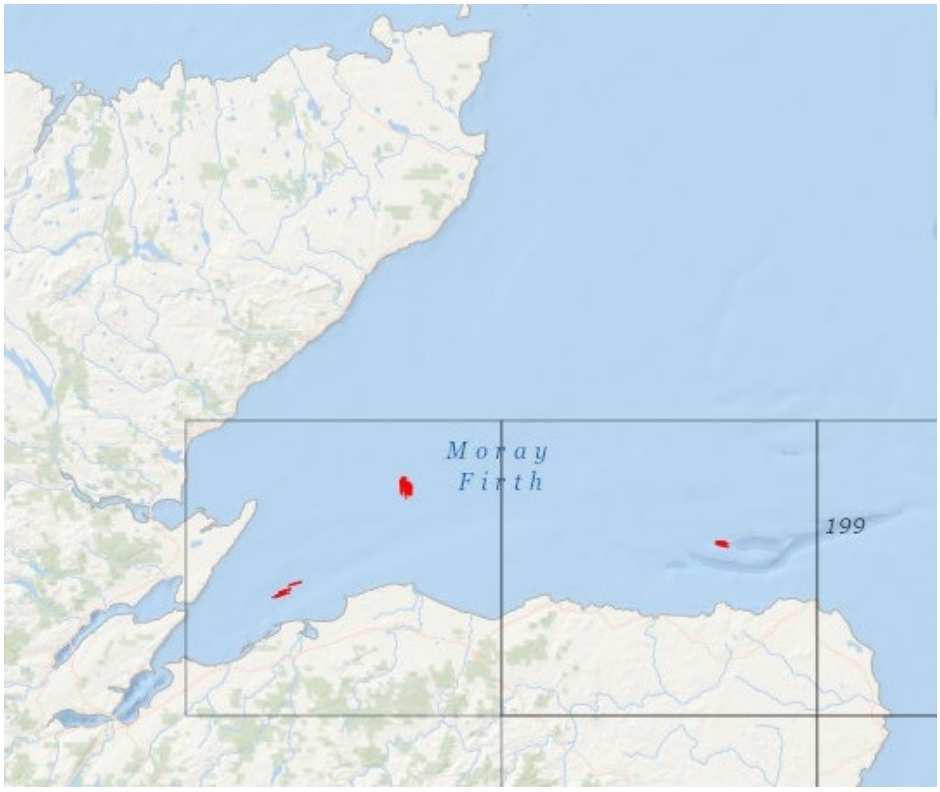


Figure 4-2 In red the locations of the fishing activities.

4.3.2 *Gear performance hauls*

After fishing, additional tows were carried out to specifically look at gear geometry specifically. The same haul procedure was used for all gear performance runs using the reciprocal tow method to account for tide or current. The gear was towed for 10-15 minutes and then hauled as the vessel turned, and gear subsequently redeployed again to start the second run. Scanmar acoustic instrumentation measured headline height, door spread, and wing-end spread. Bridle angle was derived from sweep-line length, door and wing-end spreads.

4.4 Results

23 catch comparison hauls were completed; 11 sets comparing BT237 against MI Trawl and 12 sets comparing BT237 against the Scottish GOV.

4.4.1 Catch comparison

There were sufficient quantities of haddock, whiting, common dab, Long Rough Dab, plaice, Norway lobster, Norway Pout, herring and sprat encountered by all gears for the analysis. Cod were encountered only in low numbers, and preliminary analyses suggested there was insufficient data to detect significant differences between any of the gears.

GOV catches are currently not analysed, and will be analysed later.

Overall, the catches were good for both new trawls with no species missing or noticeably sparse in one trawl when abundant in the other. Detailed analyses are in progress by the Scottish and Irish institute, but the exploratory boxplots below indicate (Figure 4-3) some catch differences. While data is obviously limited at this point, in general the trials suggested species we might associate with footrope contact/selectivity (e.g. flatfish, Norway lobster, possibly cod) seemed more prevalent in the MI trawl. Conversely, the slightly higher headline of the BT237 trawl may have influenced the higher catches of species like sprat and Norway pout.

A primary objective of the IBTS, in line with most demersal fisheries surveys, is to provide indices of recruitment of demersal and semi-pelagic fish species. Proportion at age, or length, is a key consideration and both new trawls employ a mesh size in the lower wings almost half that of the 200 mm of the GOV, so catches were expected to provide a reasonable sign of juvenile fish.

Variability in standardised length frequencies over the 12 pairs of tows can be clearly seen (Figure 4-4). Whiting and Dab in the MI trawl showed slightly higher numbers at length overall for the smaller length classes than the BT237 trawl. A quite contrasting picture for sprat can be seen.

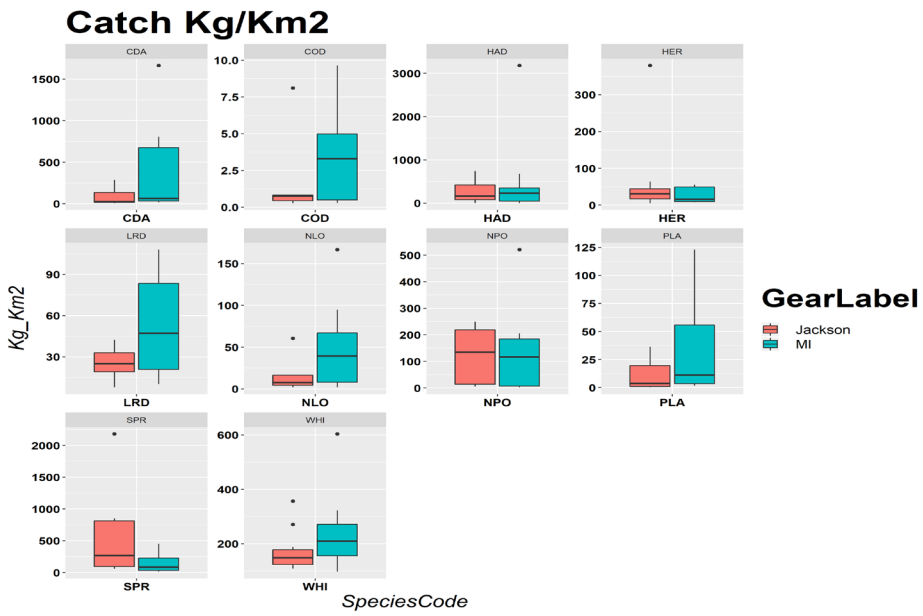
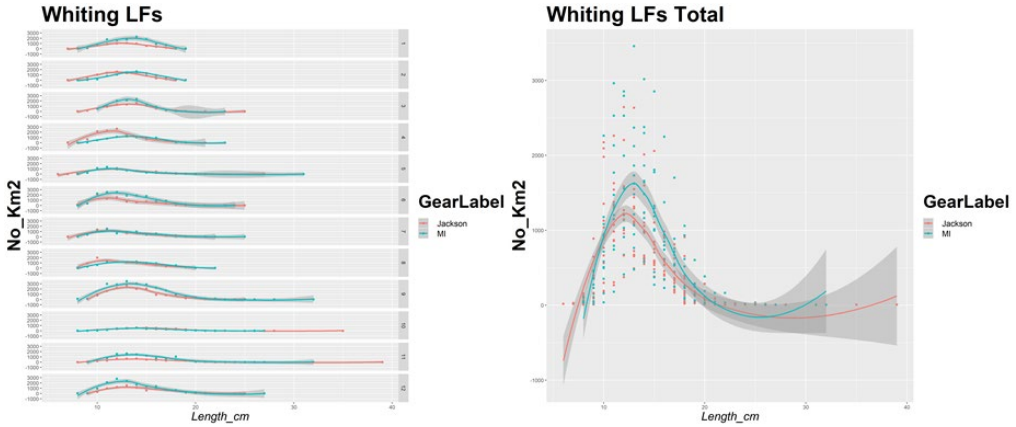
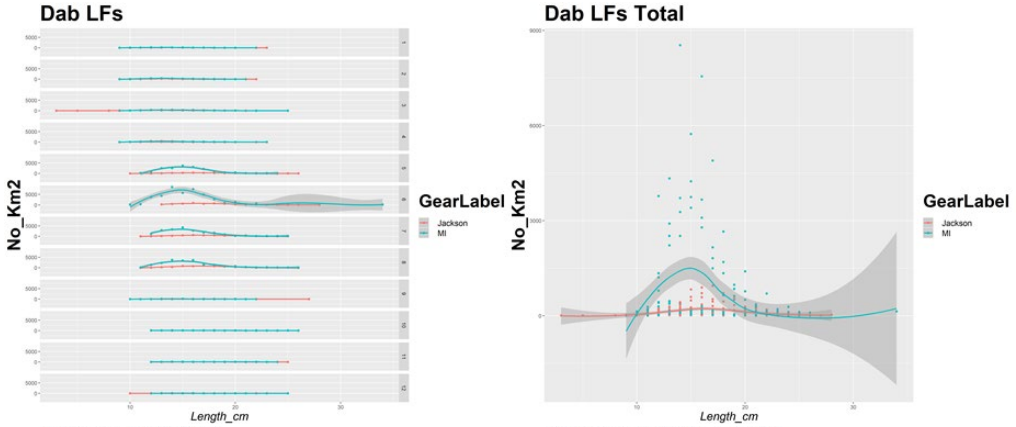


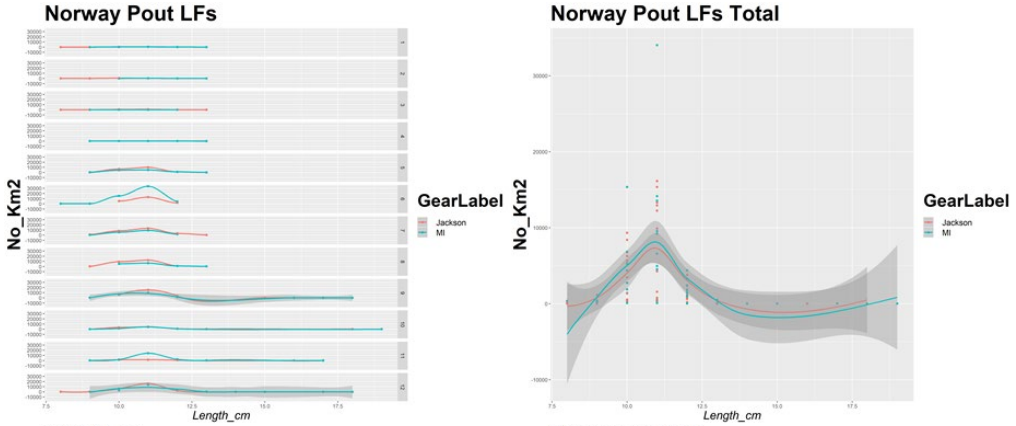
Figure 4-3 Summary of paired catch data for the modified Jackson (BT237) and MI trawl. **Species presented are Dab (CDA), Cod (COD), Haddock (HAD), Herring (HER), Long Rough Dab (LRD), Norway Lobster (NLO), Norway Pout (NPO), Plaice (PLA), Sprat (SPR) and Whiting (WHI).**


Whiting LFs
No_Km2
Length_cm
GearLabel
Jackson
MI

Whiting LFs Total
No_Km2
Length_cm
GearLabel
Jackson
MI


Dab LFs
No_Km2
Length_cm
GearLabel
Jackson
MI

Dab LFs Total
No_Km2
Length_cm
GearLabel
Jackson
MI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Length_cm
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Jackson
MI

Norway Pout LFs Total
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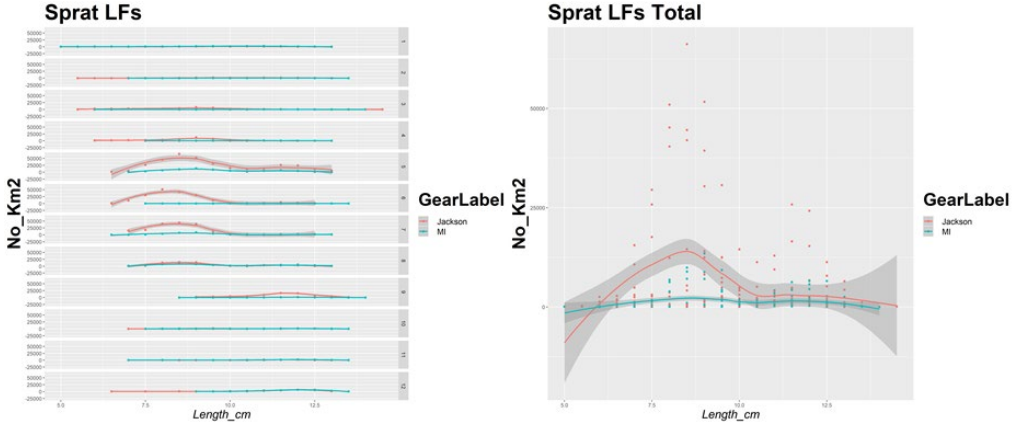
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MI

Sprat LFs Total
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Length_cm
GearLabel
Jackson
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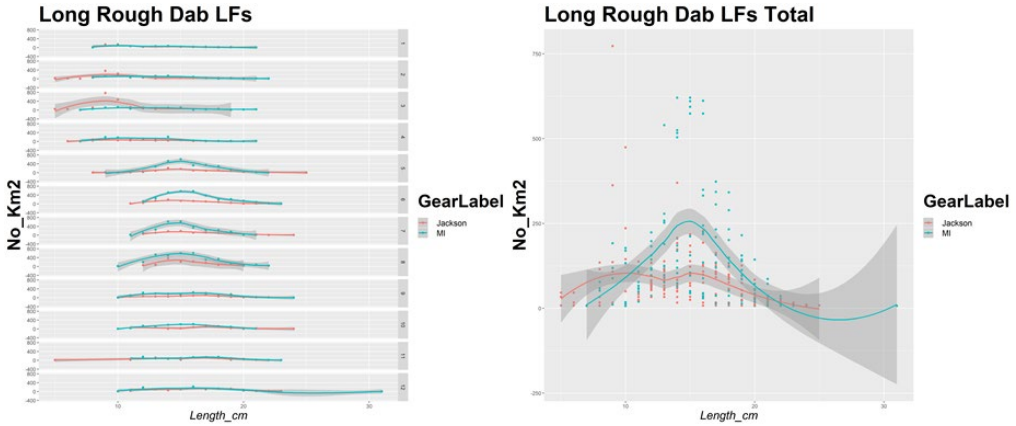

Figure 4-4 Summary of length frequencies by species for paired hauls (left panels) and simply combined over the 2019 trials (right panels). **No's are standardised to swept area for more direct comparison. The plots show a simple Loess smoothed line through the data with 95% confidence intervals.**

It seems plausible that the preliminary catch differences seen in these preliminary plots are partly caused by ground contact of the MI gear versus headline height of the BT237. Footrope and headline height are not totally fixed for either net design. Next to that, it is a working principle that both net designs are likely to have two groundgear versions, like the current GOV operation has. Using both groundgear versions means the differences in catchability will maintain, within the survey.
In these trials, the BT237 was rigged with a hopper footrope that would be similar to the GOV B-gear. The MI trawl would equate more closely to the GOV groundgear type A with smaller disks and generally higher selectivity, but less robust. Either net could use the alternate groundgear depending on the terrain they have to operate in and target species. Likewise rigging and buoyancy could address some headline height and sweep angle differences if they are deemed to negatively impact target species and levels required.
The important and positive outcome from the trials was that both the modified commercial design and the fully new design were both stable, and easy to handle. Differences are likely to be largely due to rigging changes, separate to the net plan, that will be optimised during trials of the final design.

4.4.2 Gear performance

Gear performance data for the comparative fishing hauls is presented in Table I-1 and Table I-2 (Annex I). Gear performance runs using acoustic instrumentation were completed with both BT237 and MI Trawl to a lesser extent. The BT237 gear performed well and no adjustments were required to fish properly in shallower depths (30–80 m). No issues were encountered such as digging in, compromised gear geometry or loss of bottom contact.

Using a 3:1 warp/depth ratio, gear parameter data for all BT237 hauls completed in 2018-2019 show that an increasing depth leads to an increased door and wing-end spread and to a decreased headline height (Figure 4-5).

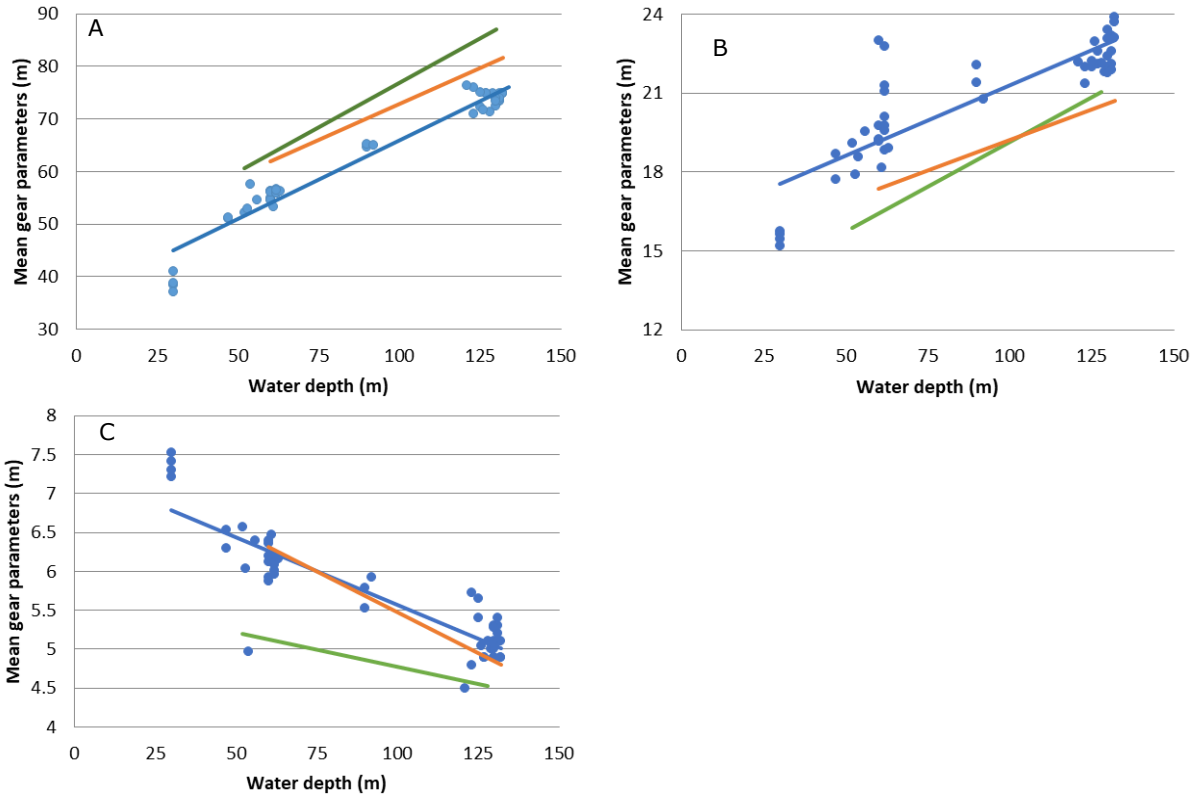

Figure 4-5 All Gear performance at depth for BT237 (2018-2019, blue) with trend data lines for MI Trawl (green) and GOV (Orange). A) door spread, B) wing-end spread; C) headline height.

The difference in door spread between the BT237 and MI-trawl/GOV suggests the heavier clean ground gear is providing slightly increased drag compared to the light hopper rig, resulting in a smaller door spread for the BT237. Bridle angles were similar for both new gears and ranged between 9-10 degrees in depths <80 m increasing to 13.5-14.5 degrees for the 4 paired hauls made in deeper water (~122 m). Because of the difference in door spread the swept area was somewhat higher for the MI trawl (Figure 4-6), but this can be modified for most trawls to a reasonable degree.

In 2018, the fishing performance of the GOV in deeper water (120-130 m) indicated serious instability of the gear (ICES 2019a), while in the 2019 experiment in shallow water it was found to have better stability. Both wing and door spreads were less variable and required only limited adjustment of engine revs. This is assumed to be due to employing the correct length of sweep (47 m) for depths <70 m and demonstrates why the GOV was designed to be fished with different sweep lengths. However, it should be noted that the IBTS manual specifies the shorter sweep should be used for all Q1 surveys to maintain consistency between users (the Dutch survey uses the short sweeps only as well, also in deeper water). The GOV had far higher bridle angles compared to the two new designs and ranged between 12-13 degrees in the shallower depths (<80 m) increasing to 17-18 degrees with increasing depth. These high bridle angles suggest that this gear could be overspreading at depths >150 m, and therefore compromise catchability due to the ground gear having poor seabed contact.

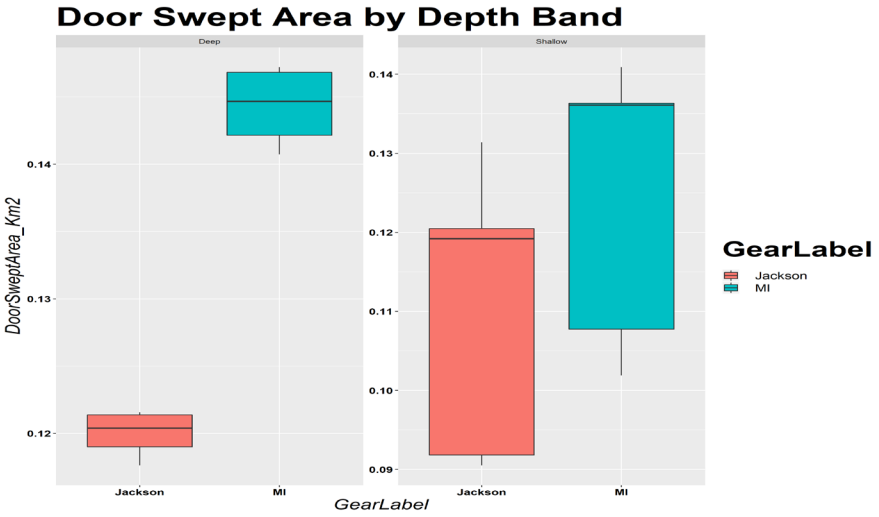

Figure 4-6 Swept area data for BT237 (red) and MI Trawl (green). **Data is grouped into two depth bands, Deep >80 m (left) and Shallow ≤ 80 m (right).**

Table I-1 and Table I-2 (Annex I) show that wingend spread and headline height of the GOV were close to those of the BT237, and with that close to the MI-gear. The door spread is larger than that of the BT237, and however not one on one comparable seems closer to the door spread of the MI-gear.

4.5 Dutch observations

4.5.1 Introduction

The Dutch gear technician and boatswain would have worked happily for another couple of years with the current GOV. They agree that it is a somewhat complex design, but they are used to work with it and currently on board there are no major issues operating the gear. Furthermore, it seems that all the materials to manufacture the Dutch net are still available. They also had the impression that their net was still close to the original gear plan from the manual. Furthermore, damage in the Dutch survey is limited and new nets are not needed that often (in contrast to the Scottish survey), limiting the costs.

Some deviations and adjustments made to the Dutch GOV compared to the original design:

- From the start of using the GOV the Exocet kite was replaced by a wooden board, which was much easier to handle, but makes the upward force harder to control.
- Changes over time were made in the types of swivels.
- In the field the length of the groundrope is adjusted by the crew, as it stretches due to frequent use, to maintain good ground contact.
- A few mistakes were made in some years, for example measuring the length of the bridles without the swivels.

Furthermore, they have the impression that the gear is similar to the manual, and similar to the gear used in earlier years.

After doing the Dutch survey on the English Endeavour (2015 & 2016), the Dutch gear technician and boatswain, who were both on board at that time, realised that there were numerous differences between the gears and the operation of the gears that might impact the catch (ICES 2015). For example: the English net was attached looser to the groundrope. Compared to the Dutch rigging, the net opening is higher, and flatfish can escape easily through the space between the groundrope and the net. Other differences observed were the netting materials and the doors used, the speed of deploying the net, the depth-warp ratio and the way it was decided if the gear was stable and fishing.

Seeing these differences resulted in proposals for adjusting the Dutch gear, for example "we should have different doors", "we should fish with heavier groundgear", "we should adjust our warp:depth-ratio", etc. This became stronger when the gear review of the IBTSWG was finished and the differences between the

countries became clearer. Although this may not be the preferred option from a scientific point of view (maintaining the time series), the review showed that changes that could make fishing easier, more consistent, more robust, eco-friendlier are recommended. The developments to a new survey gear are embraced and supported, despite the fact that Dutch crew can still work fine with the current GOV.

4.5.2 Gear trials

The Dutch staff had no remarks on the methods and way the trials were done. They both helped in sorting and measuring the catch. Their impression was that the BT237 gear was catching more sprat and the MI-gear was catching slightly more Norway pout, whiting and dab, which is in line with the preliminary analysis (paragraph 4.4.1.).

Based on the experience during the trials, both new nets could be deployed from RV Tridens without much effort. It would not require major changes and all the crew members would be able to work with both gears and repair them. There is no strong preference for either of the gears from a handling and maintenance perspective.

Both new gears contain "slack", which is not present in the current GOV. Over time netting material shrinks, which directly causes issues in the GOV. The impact of shrinkage is lower in gear with "slack" so this principle in the design was welcomed.

In both new gears the lower wing has been removed. In the GOV this is the part were most often the damage occurs. The Dutch staff however questioned if the removal of the middle bridle would not result in a loss of stability. That seemed solvable with an additional steel wire, reducing the concerns.

Based on the catches and the performance of the gears the Dutch staff had a slight preference for the simpler MI-trawl. The gear is easier to handle and to repair, besides that with the current rigging it caught more demersal (flat)fish. However, they had remarks on:

- The smallest mesh size of 78 mm is wide, 50 mm is preferred, in line with the current GOV (in the BT237 the smallest mesh is 50 mm). It is unclear how this could be solved, as using the 1/1 ratio to go from 78 to 50 seems not to be possible;
- The 3 mm net material is too light, making the net vulnerable;
- It is unclear how the lower speed preference of this gear influences catches of larger fish and rare species.

The Dutch staff remarked the following on the BT237 gear:

- The groundgear, but also other materials as connectors and swivels, are too heavy for the shallower waters where the Dutch sampling takes place;
- The 1/1 joining and easier cut of the MI-gear would be preferred.

For both gears the used materials can still be altered. The BT237 can be fished with a lighter groundgear, while the MI-trawl can be made of stronger materials.

The Dutch staff further advised to investigate the difference in sweep angle and its impact on herding of species. They also advised to look at different door types and strongly recommend that all countries use the same type of doors.

If the final gear is realised, they advise to do similar gear trails on each of the vessels, including RV Tridens. The specific vessel conditions will require developing vessel specific warp:depth-ratios, and protocols for setting and handling the gear. Also, these national protocols should be clear and reproducible prior to implementing the new gear into the survey and should largely be implemented in the international manual.

4.5.3 Additional observations

While being on board for the gear trails the Dutch staff also observed other aspects relevant to mentioned, which are related to the research vessel or the handling of the catch.

The Scotia is equipped with an auto-trawl system, which is considered very useful. The use of sensors to detect the tension on the warp facilitates maintaining a more optimal net geometry. This results in a more constant speed of the net over the ground. Unfortunately, it is not possible to implement this on board RV Tridens due to the current winches. This makes also clear that even when the new and standardized gears are introduced, differences in fishing practice between the countries will still exist and can't be easily standardized.

The subsampling on board of Scotia is done in a different manor compared to our way of working. For the Dutch observer it was a somewhat confusing way, but it seemed to work in the end. However, it still left some questions about the correct weighing of the total weight per species.

The electronic CEFAS measuring board was used in the trials, while on the Tridens measuring is still done manually. The Dutch staff experienced several benefits and just as many disadvantages. One person can do the measuring making it more efficient and there are no errors in the communication and registration of the lengths. However, the boards jammed often and switching between species required a lot of actions on the board. Measuring many species with a small number of fish is considerably slower. Furthermore, practically measuring with the electronic pen in one hand and stretching the fish with the other wasn't that easy. As a result, often measuring was done by one person, while entering in the board was done by another.

5 Changing gears in a scientific context

In June 2019 the workshop on impacts of planned changes in the North Sea IBTS (WKNSIMP, (ICES 2019b)) took place. One of the main subjects of the workshop was to broaden the discussion on the gears outside the IBTSWG and to make clear recommendation on how to implement a huge change as a new gear to a long-running survey is.

When proposing a gear change often the first point raised is that the gear must have the same catchability as the current gear (in this case the GOV) to maintain the time series. However, each of the GOVs in use has a different catchability, and for some of these the catchability changed over time. Furthermore, remaining the same catchability would result in the GOV as the new gear, which is not the preferred outcome.

The second point raised is mostly that extensive gear calibration experiments must be done to estimate conversion factors when the catchability is not the same. Here, again the question is for which GOV these experiments should be carried out, or that it should be done for all GOVs separately. As the current IBTS has many objectives, conversion factors for all these objectives should be calculated in some way. Standard gear experiments fishing them side-by-side, or one-after-the-other all require many samples to be able to estimate a conversion factor. And this must be done in all the habitats covered, with different weather and sea conditions. Past experiences learned that this is nearly impossible and would require an enormous effort.

WKNSIMP was clear that both points were not the route they wanted to take and set evaluation criteria for the gear trials. Those should show that the gear is stable, and that the gear is catching the whole set of species currently caught in the IBTS. When those results are promising, the new gear should be introduced stepwise for the IBTS in the 1st and 3rd quarter, starting on board vessels that both spatially overlap and that have precise estimates of ship effects (combined ships and gear effects). This could mean that a part up to half of the survey will be done with the new gear, and the other part with the current GOV. When the spatial distribution of the GOV stations still covers the whole North Sea, separate indices could be produced for the GOV stations and the new gear. The survey design analyses have shown that reducing the effort with 50% maintaining spatial coverage had little impact on the indices and assessments (ICES 2019a). In this way two overlapping time series can be created which can be compared. By conducting the survey with both gears for a couple of years (preferably 5 or more) both time series can be combined statistically, and the time series will not be lost as it can be translated into the new time series.

6 WKNSIMP Roadmap for implementation the gear change

WKNSIMP created the following roadmap (including the comments made by the IBTSWG 2020):

- Nov/Dec 2019: Scotia gear trials

- Apr 2020: IBTSWG decides on gear
  IBTSWG 2020: Unfortunately, not possible as due to the Covid-measures analyses were not done yet. Furthermore, it was considered best to postpone this to after the workshop referred to in the following bullet and take advantage of the next gear trials end of this year.
  At this moment, it seems likely that further gear trials on the Scotia will be postponed till late 2021.

- May 2020: Workshop with scientists in charge and fishing masters
  IBTSWG 2020: Due to the Covid-measures a new Workshop in May is impossible, it is extended till later this year.
  The current situation indicates that most people won't be allowed to travel even until the end of 2020, making it most likely that the workshop will be held in the period April-June 2021.
  IBTSWG: The Terms of Reference for this workshop are developed.

- June 2020 – Feb 2021: Gear tests by every country/vessel
  IBTSWG 2020: Potentially possible to do some tests during Q1 2021, but more likely this will become 2021-2022.
  As it is unlikely that the workshop will take place in 2020, it is unrealistic to have the gear tests early 2021. Late 2021 or even early 2022 is more realistic.

- Apr 2021: IBTSWG discuss results, define minimum and maximum limits for vertical opening and door spread for valid tows and prepare final manual on the new gear.
  IBTSWG 2020: This will be delayed as well. It requires decisions on a new gear, considering the outcomes of the workshop and the latest trials results.

- Feb 2022: structure phased implementation of new survey gear by all countries in the Q1 survey.

WKNSIMP drafted this roadmap, although some of the members felt they were lacking the mandate to make such advice. WKNSIMP discussed a long time about this issue as it is unclear who would actually have the mandate to make the decision on changing the gear. Groups as the IBTSWG and WKNSIMP can only recommend this to ICES. ICES can't make the decision as the surveys are part of the EU legislation and the surveys are organised nationally. WKNSIMP proposed as a way forward to present preferred changes to the Regional Coordination Group for the North Atlantic and the North Sea (RCG NA & NSEA).

7 Conclusions and recommendations

The Scottish gear trials were successful as they showed that both gears are stable and catch a similar fish community as the current GOV, thus matching the evaluation criteria set by WKNSIMP. The Dutch participation during these trials was useful as it gave the Dutch staff involved in the IBTS a better insight in the process of developing the new gears and in the new gears itself. The involvement in the trials resulted in that the suggestions from the Dutch staff will be taken on board in the process. Furthermore, it gave an insight on how the Scottish survey is done.

There is still a lot of work to be done, before a new gear can and will be implemented in the survey. First the results of the extended analyses of the trials need to become available. With these results, the proposed workshop (chapter 6) must give advice on which gear aspects, from the prototypes provided to the group, and materials should be adopted.

The data on both gears currently indicate that both fish properly and there is limited difference between them. This poses a risk for the discussion on the final choice, which might end up in personal or national preferences, as it can be expected that the gear developers prefer their own gear above the other. The Dutch staff had a slight preference for the easier design of the Irish gear. Despite this risk, a decision needs to be made at least for the whole North Sea IBTS survey. This decision has to take account of:

- Fishability and stability of the gear;
- Catches comprising the same (or larger) part of the fish community as the GOV;
- Easiness of handling and maintenance;
- Durability and sustainability;
- Cost of the used materials.

Following a decision on the final gear design for the North Sea IBTS, the other net may still be used in one or more of the north east Atlantic surveys. Despite this, it is intended that the workshop advises on a combination of the best aspects of both gears, which will be supported by all participants. Following the advice on the net, the workshop should also advise on doors to be used as well as possibly warps, towing speed and finally any important revision to trawl monitoring.

Following the workshop, most likely there is a wish for another two weeks of trials. Here, the net and the new doors advised by the workshop should be tested if available at that time. The focus should be on getting all the details right in the rigging and the lengths of the bridles etc. Furthermore, there are still some questions related to the sweep angle and the effect of this on the herding of fish, which require attention.

Thereafter a detailed manual with fishing protocols should be made as the overall guideline. The workshop could already do the first steps for this. These protocols should leave less space than the current manual for the GOV. However, it should still leave space to include the differences between vessels and the necessary impact of this on the rigging. Because of this, every country will have to make their own protocols when they start fishing with the new net on their vessel. For this it is likely that all countries, including the Netherlands, will need to do some test fishing with the new gear. Possibly, it is necessary to share a few new nets amongst the countries, before every country purchases a full set of new gears.

It is possible to compare the GOV and the new gear on board RV Tridens, as both gears can be rigged on board at the same time. Test fishing requires the net geometry sensors currently available. Additionally, wing sensors and a bottom contact sensor would be very useful. Sharing these sensors amongst countries might be a possibility. Test fishing on board RV Tridens should be planned for late 2021 or in 2022.

When test fishing is successful the implementation could take place, possible Q3 2022 or Q1 2023. Some of the vessels can have both gears rigged. These vessels, including the Tridens, could fish a part of their

stations with either one of the gears. The other countries might be able to switch gears halfway a survey, or they must do the full survey with one or the other net. This will require some planning for both quarters to make sure an index based on the GOV can still be calculated, while the new gear is sufficiently used to calculate and index as well.

The currently proposed method of implementing the gear would mean that the GOV and doors will be used by most countries at least until 2027/2028. This means that the countries will need to invest in new gears, still maintaining the old ones. Some of the IBTS participants already suggested that this might be an issue in their country, depending on the costs of the new net. In those cases a quicker shift to the new gear is needed. Potentially, these kinds of issues could (partly) be covered by sharing nets and other equipment.

So far this sounds, despite the delays owing to Covid-19, as workable plans that are supported by the Dutch staff in the IBTS. IBTSWG participants from a number of other countries also support the change to a new gear. In Scotland and Ireland work has been carried out for a couple of years now, showing the willingness to change their nets. In previous trials Norway actively participated and the progress made is supported. Active support also comes from Denmark, shown by initiation of WKNSIMP.
Some of the other countries are keeping themselves to the background, they are not opposing the process but neither full out supporting it. In most cases the mandate issue, as discussed by WKNSIMP, plays a major role. Besides that, they expect that the cost issue will cause problems nationally. There are also worries that clients of some national objectives which are based upon the IBTS, could be very reluctant to a change in gear. In the Netherlands this might play a role for the seafloor litter indicator based on the IBTS catches. However, this is not a primary objective, in contrast to the national objectives in some other countries.

The ambiguity about the mandate and the hesitation of support by some of the participating countries forms a risk. It might slow down the process or even cancel the process. On top of that, the Brexit could make it even more difficult as England has clear national objectives for their Q3 IBTS. Therefore, they are unwilling to change their IBTS spatial coverage. Moreover, England is the only country running the IBTS with a fixed station design. The English gear has been changed to a full polyethene net and a different designed net, a hybrid net. However, the English involvement in the current process is limited.

It is thus needed to emphasize why a change of gear at this time is the most sensible route:

- The current time series has issues related to the differences in the current GOV's used by the different countries and owing to the technical creep within a country;
- There is room for arbitrary choices in the construction drawings and manuals of the GOV;
- The GOV is outdated:
    - Materials are no longer available or getting very expensive;
    - The knowledge of making and handling this gear is reducing;
    - Economically and Ecologically no longer an efficient method (more efficient doors, more robust netting);
- The habitat in which the GOV can fish is limited; a new gear should be constructed such that it can extend the current habitat to follow the fish moving north into deeper waters.

8 Acknowledgments

Thanks to the crew onboard of FRV Scotia for allowing us to participate and to help us on board where needed. Special thanks to Rob Kynoch and Dave Stokes for providing the net drawing, large parts of the text and all their work in developing a new net for the IBTS.

9 Quality Assurance

CVO is certified to ISO 9001:2015 (certificate number: 268632-2018-AQ-NLD-RvA). This certificate is valid until December 15th, 2021. The certification was issued by DNV GL Business Assurance B.V

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Justification

CVO Report: 20.026
Project number: 4311300078

The quality of this report has been peer reviewed by a colleague scientist and the head of CVO.

Approved by:	Ingeborg de Boois Colleague scientist
Signature:	
Date:	18th of November 2020

Approved by:	Ing. S.W. Verver Head Centre for Fisheries Research
Signature:	
Date:	18th of November 2020

Annex I Gear performance data

Table I-1 Gear performance data BT237 v MI Trawl; **MDS: Mean door spread; MWS: Mean wing spread; MHH: Mean headline height; MSoG: Mean speed over ground.**

Paired Hauls		BT237				MI Trawl			
(1st – 2nd)		MDS (m)	MWS (m)	MHH (m)	MSoG (kts)	MDS (m)	MWS (m)	MHH (m)	MSoG (kts)
MI	BT237	52.1	19.1	6.57	3.67	61.1	16.3	5.27	3.57
BT237	MI	52.9	17.9	6.03	3.63	60.4	15.9	5.24	3.66
MI	BT237	57.5	18.6	4.97	3.69	59.7	16.4	5.36	3.66
BT237	MI	54.6	19.5	6.39	3.57	64.1	17.9	5.10	3.60
MI	BT237	53.3	18.2	6.47	3.66	61.3	15.1	5.21	3.64
MI	BT237	55.0	19.2	6.12	3.67	64.3	15.9	4.86	3.57
BT237	MI	54.6	23.0	6.36	3.66	64.7	15.8	4.96	3.66
MI	BT237	54.5	19.2	6.39	3.64	61.6	15.9	5.18	3.66
BT237	MI	72.3	22.2	5.65	3.64	86.7	21.6	4.61	3.68
MI	BT237	71.3	22.1	5.11	3.64	86.8	21.0	4.54	3.65
BT237	MI	71.6	23.0	5.04	3.67	85.1	19.9	4.52	3.59
MI	BT237	70.9	21.3	5.72	3.62	83.8	21.3	4.55	3.67

Table I-2 Gear performance data BT237 v Scottish GOV; **MDS: Mean door spread; MWS: Mean wing spread; MHH: Mean headline height; MSoG: Mean speed over ground.**

Paired Hauls		BT237				GOV			
(1st – 2nd)		MDS (m)	MWS (m)	MHH (m)	MSoG (kts)	MDS (m)	MWS (m)	MHH (m)	MSoG (kts)
GOV	BT237	56.2	19.6	6.20	3.74	63.1	20.6	6.64	3.69
BT237	GOV	55.9	18.8	6.01	3.75	62.1	16.1	6.46	3.68
GOV	BT237	56.1	21.3	6.14	3.74	62.5	16.4	6.39	3.65
BT237	GOV	56.2	19.2	6.20	3.68	62.5	16.2	6.25	3.74
GOV	BT237	56.2	19.2	5.88	3.71	61.5	16.1	6.24	3.62
BT237	GOV	56.1	19.8	5.92	3.73	61.2	17.8	6.25	3.71
GOV	BT237	55.9	21.1	6.09	3.73	63.0	16.9	6.16	3.66
BT237	GOV	55.8	19.8	6.12	3.69	62.0	18.3	6.16	3.73
GOV	BT237	56.6	22.8	5.96	3.75	62.6	17.6	6.19	3.64
BT237	GOV	56.3	18.9	6.16	3.71	63.7	19.1	6.02	3.74
GOV	BT237	56.4	20.1	6.01	3.71	63.2	17.4	6.15	3.75